Wisconsin Department of Natural Resources
Aquatic Invasive Species Grant Program
Grant # AIRR-145-13

Big Lake EWM Early Response Project

Big Lake – Cisco Chain of Lakes

Vilas County, WI & Gogebic County, MI

Final Reporting

2017

Submitted To:

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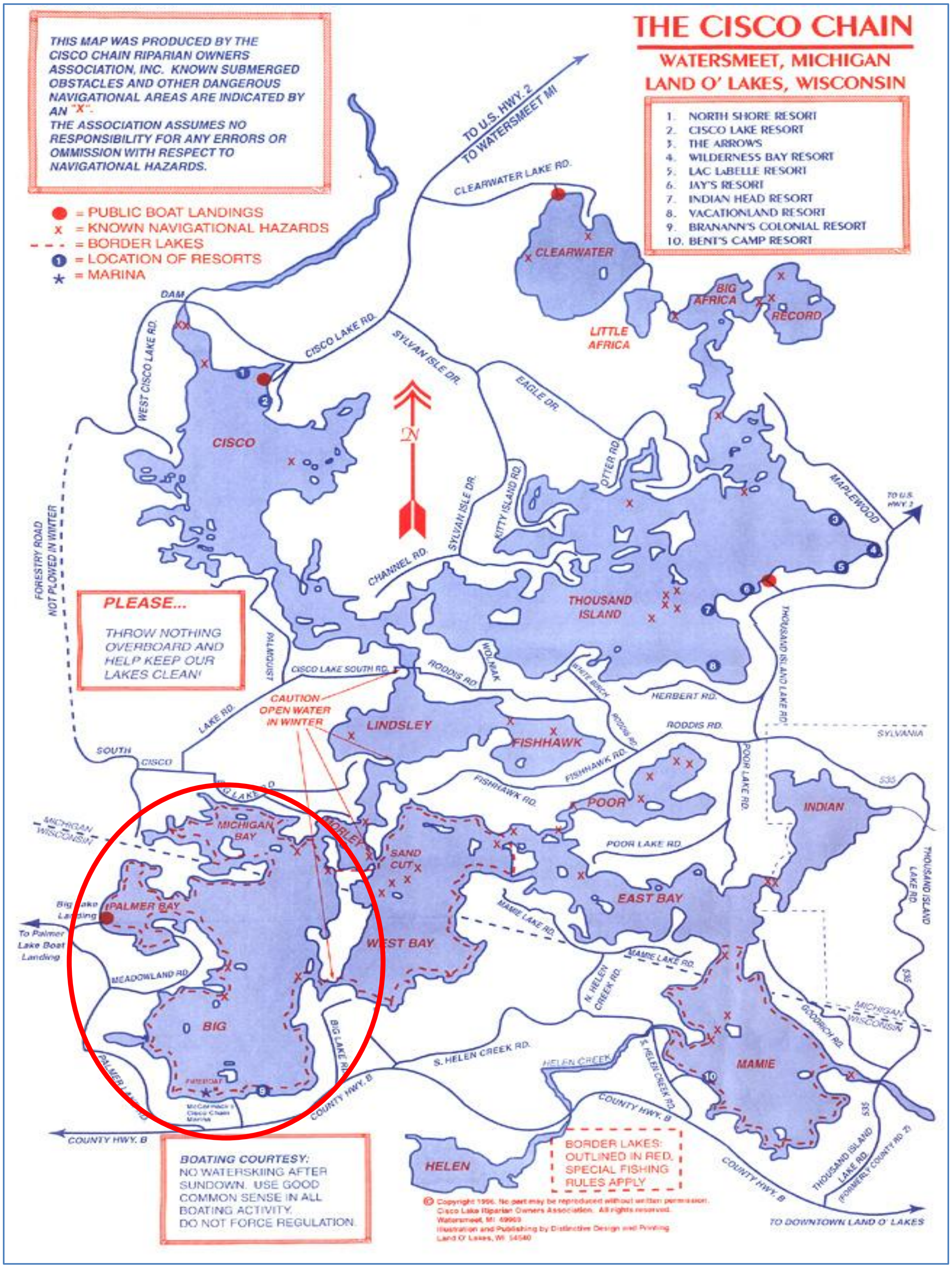
OVERVIEW

This report is a summary of activities from 2015-2017 completed under the Big Lake WDNR Aquatic Invasive Species Grant # AIRR-145-13. Specifically this report is a synthesis of (1) seasonal Eurasian watermilfoil (EWM) monitoring findings, (2) EWM management and management evaluation, (3) aquatic vegetation monitoring and (4) discussion of project highlights.

PROJECT AREA

Big Lake, located in Vilas County, WI and Gogebic County, MI is a 780 acre shallow lowland lake with a maximum depth of 30 ft. Big Lake is one of fifteen named lakes that make up the Cisco Chain of Lakes ("Chain"), with a total surface water area of approximately 4,025 acres (WNRB, 2013). Access to Big Lake includes a boat launch owned by the WDNR and two channels, one that connects Big Lake to Morley Lake to the north and one that connects to West Bay Lake to the east. A private marina also provides boat/trailer access. In addition to the public access on Big Lake, four public and one private-pay access sites are located across the Chain. Big Lake riparian ownership includes the WDNR, State of Wisconsin Board of Commissioners, University of Notre Dame, Michigan and Wisconsin riparians. Several lakes on the chain boarder USFS Ottawa National Forest and Upper Peninsula Power Company (UPPCO) owns/operates a water level control structure at the far northern end of Cisco Lake, the headwaters to the Cisco Branch of the Ontonagon River.


THE CISCO CHAIN
WATERSMEET, MICHIGAN
LAND O' LAKES, WISCONSIN
THIS MAP WAS PRODUCED BY THE CISCO CHAIN RIPARIAN OWNERS ASSOCIATION, INC. KNOWN SUBMERGED OBSTACLES AND OTHER DANGEROUS NAVIGATIONAL AREAS ARE INDICATED BY AN "X".
THE ASSOCIATION ASSUMES NO RESPONSIBILITY FOR ANY ERRORS OR OMMISSION WITH RESPECT TO NAVIGATIONAL HAZARDS.
= PUBLIC BOAT LANDINGS
x = KNOWN NAVIGATIONAL HAZARDS
= BORDER LAKES
= LOCATION OF RESORTS
= MARINA
1. NORTH SHORE RESORT
2. CISCO LAKE RESORT
3. THE ARROWS
4. WILDERNESS BAY RESORT
5. LAC LaBELLE RESORT
6. JAY'S RESORT
7. INDIAN HEAD RESORT
8. VACATIONLAND RESORT
9. BRANANN'S COLONIAL RESORT
10. BENT'S CAMP RESORT
TO U.S. HWY. 2
TO WATERSMEET MI
CLEARWATER LAKE RD.
CLEARWATER
BIG AFRICA
RECORD
LITTLE AFRICA
DAM
CISCO LAKE RD.
WEST CISCO LAKE RD.
SYLVAN ISLE DR.
EAGLE DR.
CISCO
N
KITTY ISLAND RD.
OTTER RD.
MAPLEWOOD
TO U.S. HWY. 2
CHANNEL RD.
THOUSAND ISLAND
FORESTRY ROAD NOT PLOWED IN WINTER
PLEASE...
THROW NOTHING OVERBOARD AND HELP KEEP OUR LAKES CLEAN!
PALMQUIST
CISCO LAKE SOUTH RD.
RODDIS RD.
WOLNIAK
WHITE BIRCH
HERBERT RD.
THOUSAND ISLAND LAKE RD.
CAUTION OPEN WATER IN WINTER
LAKE RD.
LINDSLEY
FISHHAWK
RODDIS RD.
SYLVANIA
SOUTH CISCO
FISHHAWK RD.
POOR LAKE RD.
POOR
INDIAN
MICHIGAN WISCONSIN
MICHIGAN BAY
MORLEY
SAND CUT
POOR LAKE RD.
EAST BAY
THOUSAND ISLAND LAKE RD.
PALMER BAY
To Palmer Lake Boat Landing
MAMIE LAKE RD.
WEST BAY
MEADOWLAND RD.
N. HELEN CREEK RD.
GOODRICH RD.
MICHIGAN WISCONSIN
BIG
BIG LAKE RD.
S. HELEN CREEK RD.
HELEN CREEK
MAMIE
PALMER LAKE RD.
COUNTY HWY. B
COUNTY HWY. B
COUNTY HWY. B
HELEN
BOATING COURTESY:
NO WATERSKIING AFTER SUNDOWN. USE GOOD COMMON SENSE IN ALL BOATING ACTIVITY. DO NOT FORCE REGULATION.
BORDER LAKES: OUTLINED IN RED. SPECIAL FISHING RULES APPLY
THOUSAND ISLAND LAKE RD.
TO DOWNTOWN LAND O' LAKES

EWM MANAGEMENT

2015

Light hand removal with the use of divers took place at a few scattered locations along the far north end of Big Lake in "Michigan" Bay. A total of 5.5 pounds (wet weight) of EWM were removed. These efforts occurred after the mid/late season EWM monitoring. A post management check of these sites did not occur, however, during the end of the season EWM buoy removal efforts a few scattered plants were detect in these areas.

Water clarity on Big Lake is a challenge to diver visibility affecting the ability to locate plants. General dive visibility through-out the mid summer season on Big Lake is poor, on average less than two feet. Dive efforts in 2015 took place on September 28th. The hope was that as the waters began to cool, divers may gain some late season visibility. Dive visibility on this day was fair, with average visbility ranging between 2-3 feet. Other than this light hand removal, the continued strategy for management of EWM on Big Lake consisted of monitoring annual EWM population trends and collect baseline aquatic plant data using a the "sub" PI. During the winter and early spring of 2016, discussions regarding future management alternatives and strategies for EWM began with the CCORA and the WDNR.

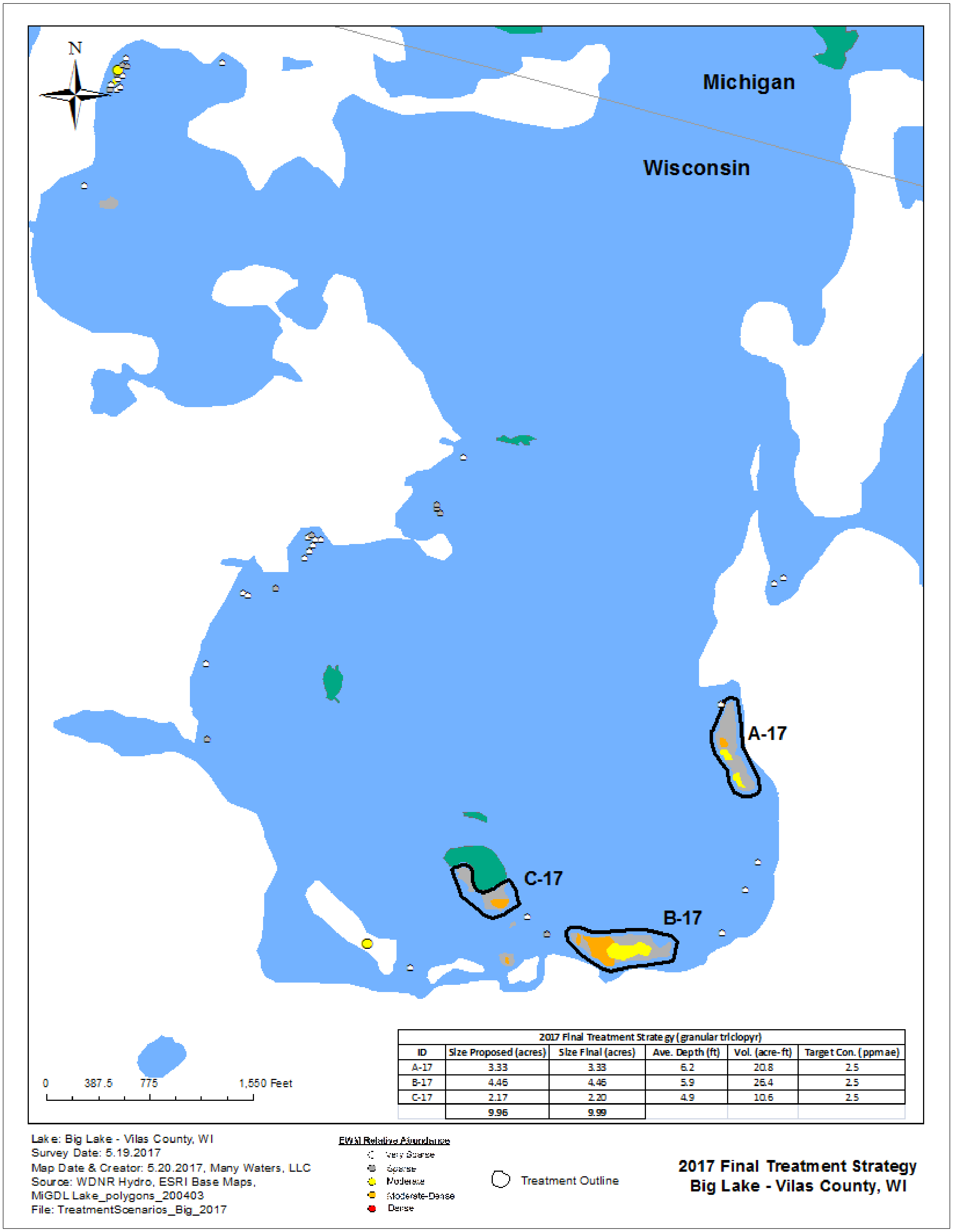
2016

Dialog with the WDNR regarding the future of EWM management continued. Annual management activities consisted of continued population monitoring and baseline aquatic plant data collection using the same PI grid from 2015.

2017

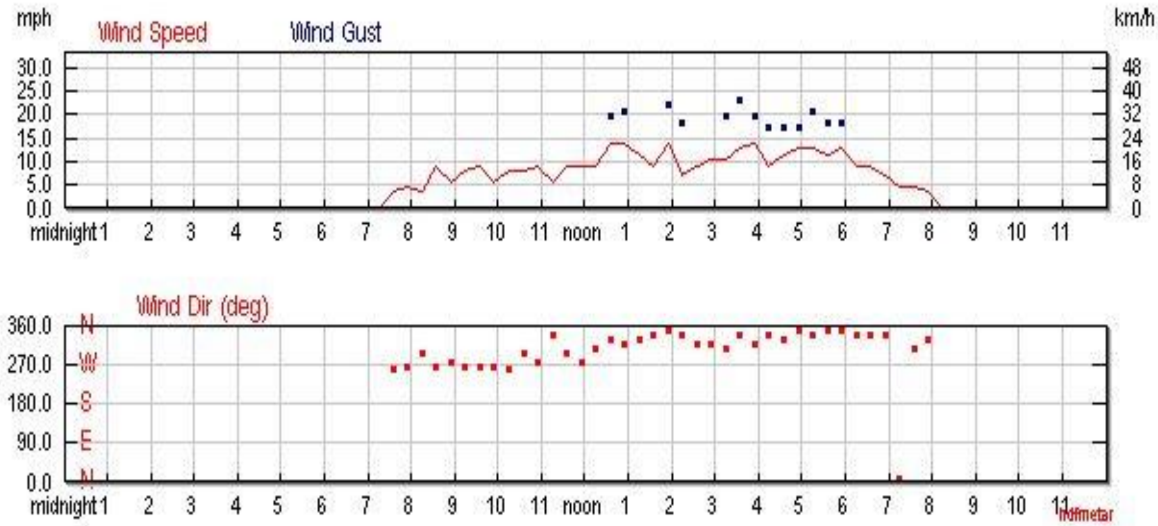
The primary management goal for 2017 was to provide recreational relief and water body access at denser EWM sites located at the southern end of Big Lake. Secondly, smaller sites, with priority to major boat traffic pathways, would be targeted with hand removal. A monitor/evaluate approach for the remaining locations of EWM and sub PI data collection continued similar to 2015 and 2016.

On June 1st 2017, an herbicide treatment using granular triclopyr (Renovate OTF) at an application rate of 2.5 ppm occurred on 9.96 acres of EWM (NO-2017-64-773). Application occurred between 8 am – 12pm, with water temperatures reported at 57.7˚F and winds at the time of treatment reported to be light out of the west.



2017 Final Treatment Strategy (granular triclopyr)					
ID	Size Proposed (acres)	Size Final (acres)	Ave. Depth (ft)	Vol. (acre-ft)	Target Con. (ppmae)
A-17	3.33	3.33	6.2	20.8	2.5
B-17	4.46	4.46	5.9	26.4	2.5
C-17	2.17	2.20	4.9	10.6	2.5
	9.96	9.99			

Figure 5: 24-hour wind speed and direction information for Land O' Lakes, WI on June 1 2017. (Taken from Weather Underground, 1.29.2018)



A combination of factors effected hand removal and DASH efforts. Initial early season surveys detected very little EWM within proposed DASH sites. Continued seasonal monitoring began to detect EWM within proposed hand harvest areas, however, water clarity by this time had deteriorated, greatly affecting diving visibility and efficiency. This resulted in no hand removal taking place on Big Lake in 2017.

During the time of treatment, water samples collected within treatment area B-17 were analyzed for triclopyr concentrations using a FastTEST© (SePRO). Using an integrated water sampler in 6 feet of water, water samples from the surface to 1 foot off the bottom were collected at 1, 2, 3, 4, 5, and 6-hour intervals.

Figure 6: FastTEST water sampling location within treatment area B-17.

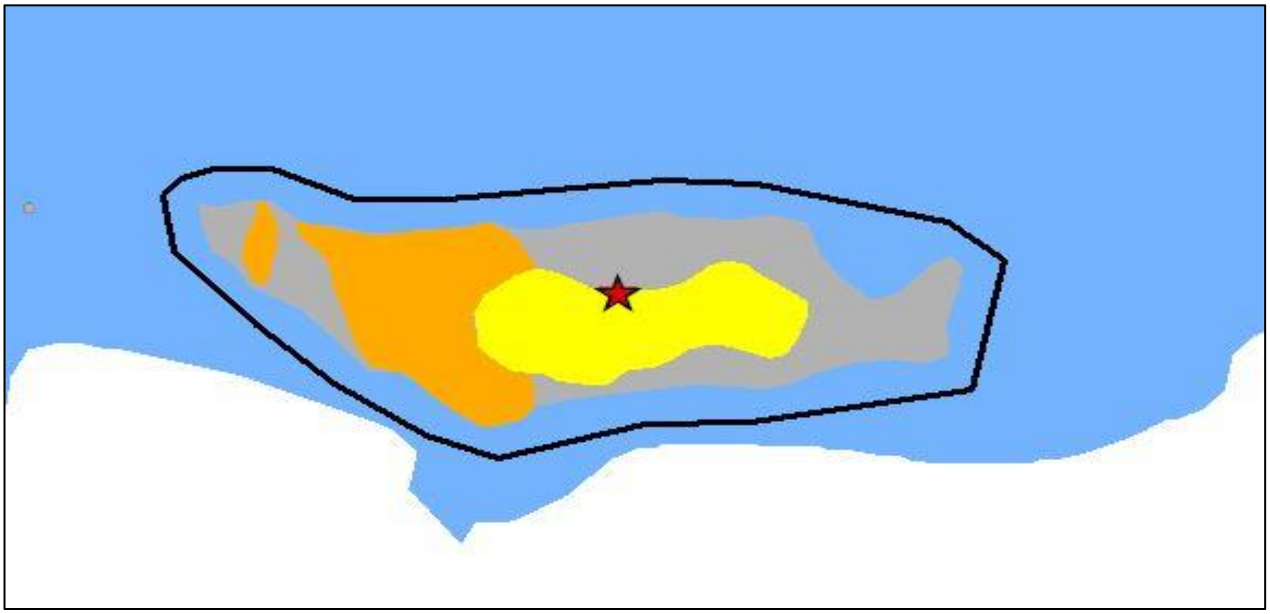
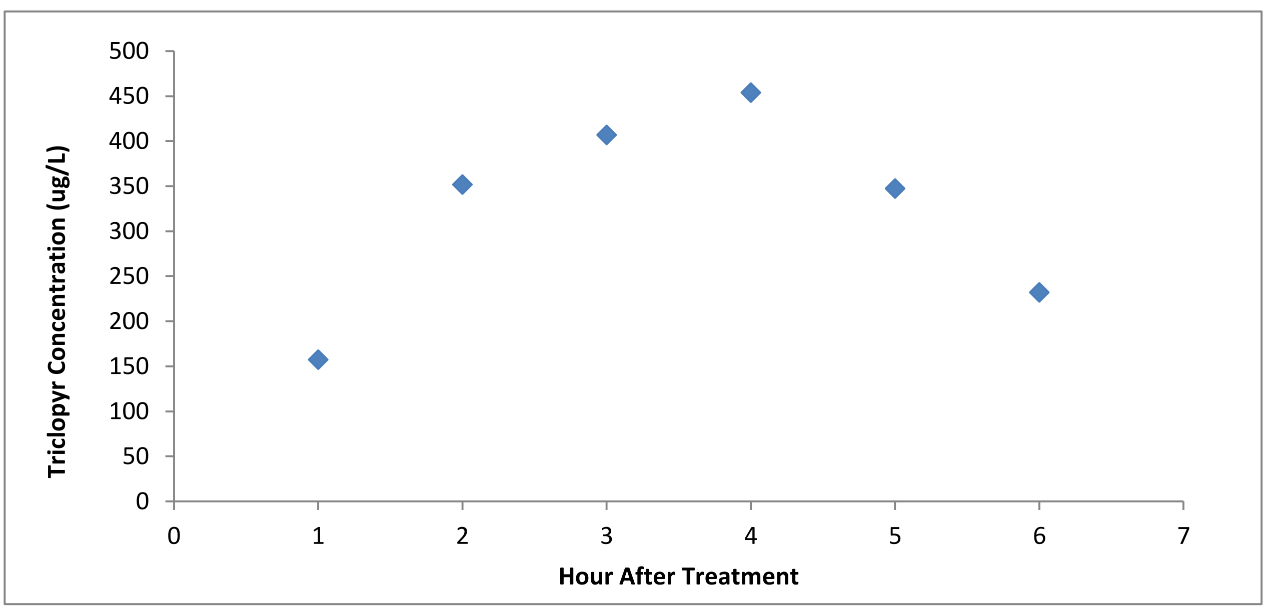


Figure 7: Measured triclopyr concentrations (ug/l) at 1, 2, 3, 4, 5, and 6 hours after treatment.



MANAGEMENT EVALUATION

Qualitative

At the end of the 2017 season, areas treated with herbicide sustained a substantial reduction of observed abundance and distribution of EWM. The qualitative success criteria set for 2017 was to see a reduction in abundance within treatment areas by one abundance ranking based on a five-part abundance estimate scale. A reduction from moderate and moderate-dense EWM beds to isolated sparse to very sparse colonies occurred. This reduction met the qualitative success criteria set for 2017 herbicide managed areas. Additionally, the treatment strategy achieved the goal of providing recreational use and water body access.

Quantitative

Treatments achieved a 100% reduction of EWM across all three treatments areas based on rake samples (presence/absence). Using a chi-square test (α = 0.05 & β = 0.80) this is a statistically validated change across all treatment sites, meeting the 2017 set success criteria. Repeating the quantitative assessment using the same grid in 2018 is suggested to provide information on multiple year control of EWM.

Point intercept sampling locations within herbicide management areas, Big Lake – 2017.

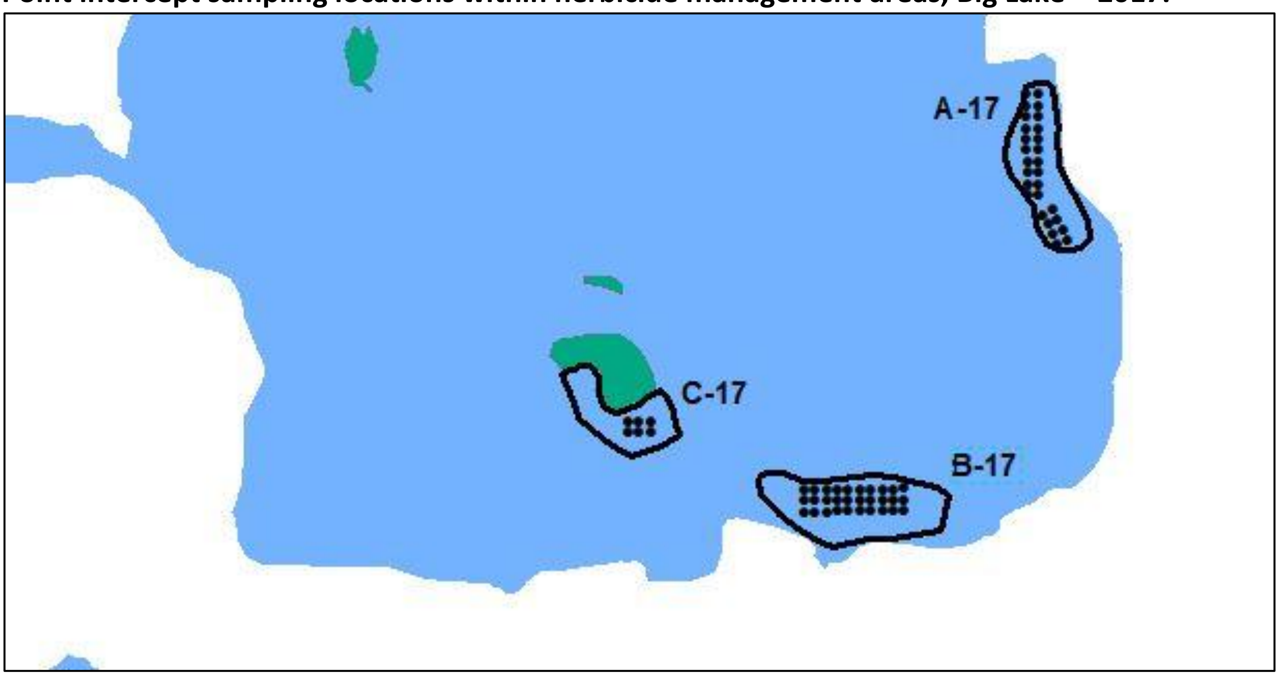
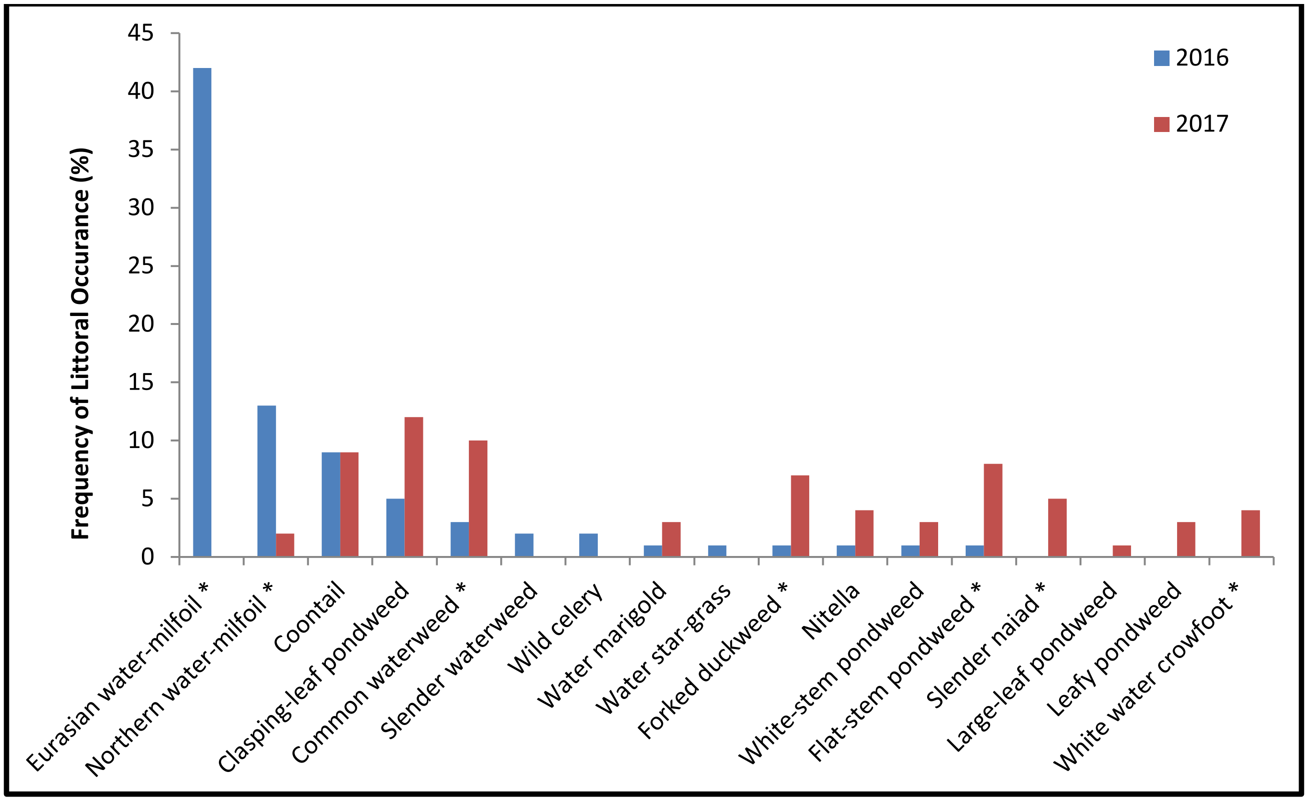


Figure 8: Change in littoral frequency of occurrence from 2016 (pre-herbicide treatment) to 2017 (year of treatment/post-herbicide treatment) within treatment sites A-17, B-17 & C-17 (lumped). *Statistically valid change (p<0.05)



SEASONAL EWM MONITORING

Qualitative-EWM

Eurasian watermilfoil monitoring surveys using a meander approach are primarily completed using visual observations, but also include the use of rake tosses and underwater cameras. Monitoring efforts are qualitative in nature, meaning that information collected describes the condition of EWM rather than using measured or quantitatively calculated values. For example, Table 1 describes the general observed abundance estimate of EWM found during each survey. Smaller sites are geo-referenced with a GPS point and extent is determined by using a visually estimated circumference converted to acres. This is an observed estimate of exact extent and not footprint. On average, these sites are less than a 0.10 of an acre in size. Larger sites, typically greater than a 0.10 of an acre in size are circumnavigated and extent in acres is calculated and represented by a polygon. Timing of monitoring surveys capture EWM plants at or near the greatest growth potential for a given year, typically second half of the growing season.

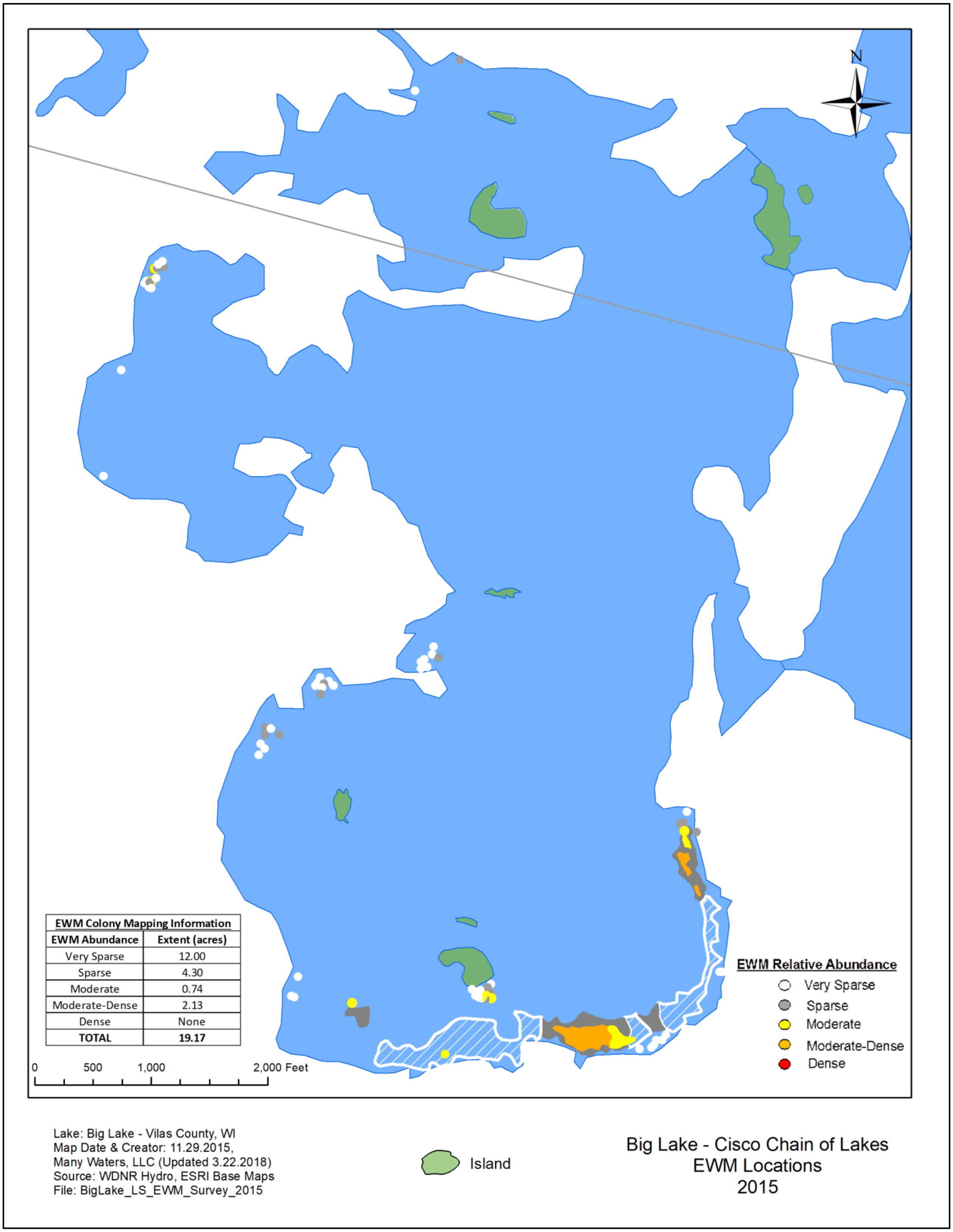
Table 1: Estimated qualitative abundance rankings.

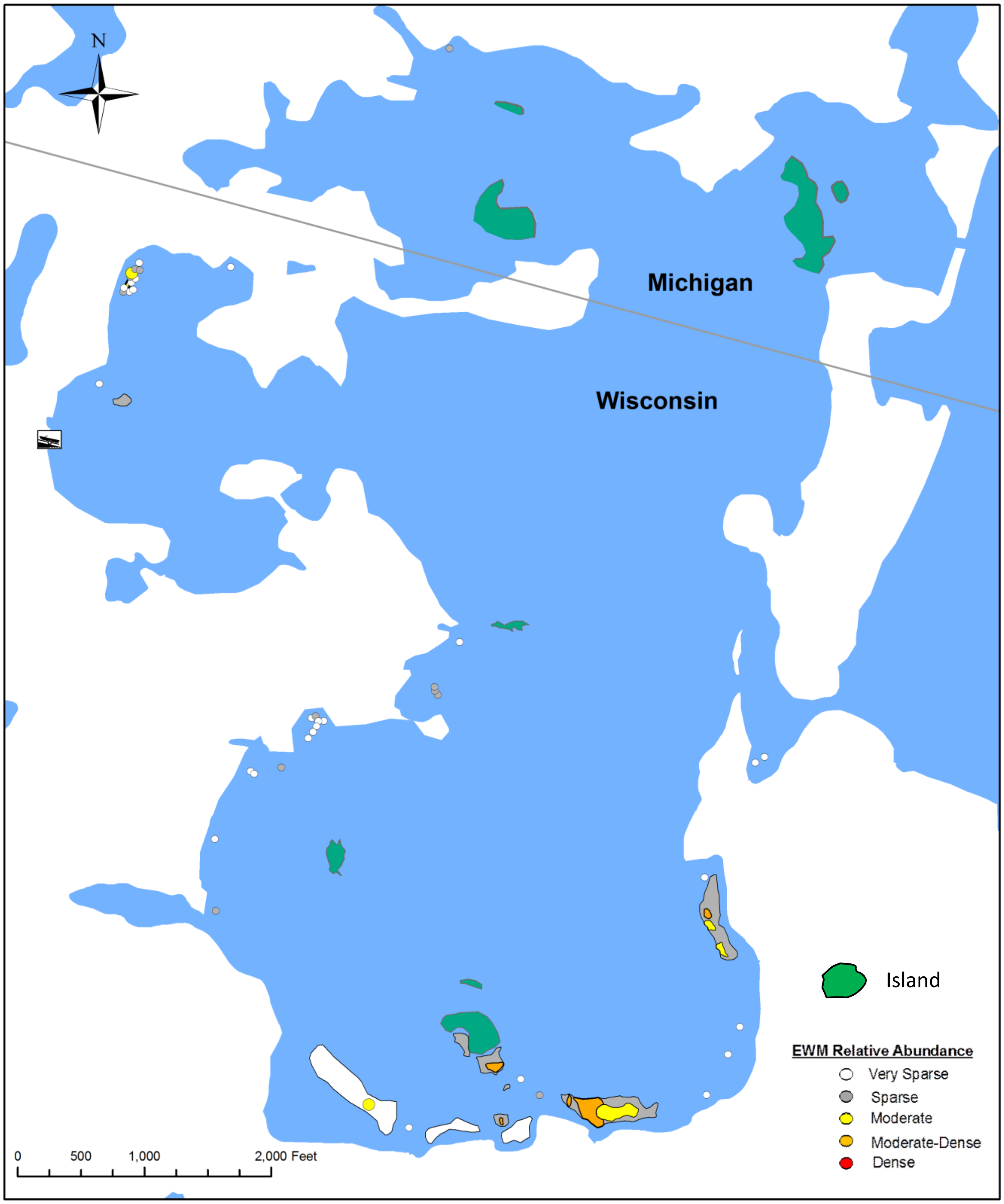
Very Sparse	Typically consists of less than 10 plants visually observed per GPS point, unless otherwise noted. Extent varies and is estimated visually for smaller locations and noted. Larger locations are delineated using GPS to calculate area.
Sparse	Typically consisted of 10-20 plants visually observed per GPS point, unless otherwise noted. Extent varies and is estimated visually for smaller locations and noted. Larger locations are delineated using GPS to calculate area.
Moderate	Typically consists primarily of EWM with some native vegetation visually observed to be intermixed. Extent varies and is estimated visually for smaller locations and noted. Larger locations are delineated using GPS to calculate area.
Moderate-Dense	Typically consists of dominant EWM with little observed native vegetation intermixed. Extent varies and is estimated visually for smaller locations and noted. Larger locations are delineated using GPS to calculate area.
Dense	Dominant EWM, with little to no native vegetation observed. Dense locations may or may not have surface matting depending on the time of year. Extent varies and is estimated visually for smaller locations and noted. Larger locations are delineated using GPS to calculate area.

Between 2015-2017, monitoring efforts detected EWM at various locations and densities across Big Lake. Generally, the greatest extent of EWM occurred at the far southern end of the lake, mainly along the southeast shore. Based on polygon bed mapping in 2015 approximately 19.17 acres of sparse to moderate-dense beds of EWM were identified.

In 2016, EWM continued to persist in similar regions as in 2015. Observed abundance of polygon based mapping along the far southeast end of the lake remained somewhat similar to 2015 for moderate to moderate-dense colonies, and declined from 2015 for sparse to very sparse colonies. Polygon based mapping in 2016 detected a total of 9.9 acres of EWM. Point-based location of EWM detected approximately 0.50 acres of EWM. Observed water quality conditions at the time of the survey were poor, limiting depth of visibility.

Monitoring efforts in 2017 detected EWM mainly north of the boat launch and the channel region from Big Lake to West Bay Lake. At the time of the survey, no EWM was detected within the treatment sites. However, an end of the year site visit of the treatment areas did detect a few scattered plants within those areas. Total estimated point based acres of EWM based on visual exact extent in 2017 was .77 acres.


N
EWM Colony Mapping Information
EWM Abundance | Extent (acres)
Very Sparse | 12.00
Sparse | 4.30
Moderate | 0.74
Moderate-Dense | 2.13
Dense | None
TOTAL | 19.17
0 500 1,000 2,000 Feet
EWM Relative Abundance
Very Sparse
Sparse
Moderate
Moderate-Dense
Dense
Lake: Big Lake - Vilas County, WI
Map Date & Creator: 11.29.2015,
Many Waters, LLC (Updated 3.22.2018)
Source: WDNR Hydro, ESRI Base Maps
File: BigLake_LS_EWM_Survey_2015
Island
Big Lake - Cisco Chain of Lakes
EWM Locations
2015



Lake: Big Lake - Vilas County, WI
Map Date & Creator: 2/12/2017, Many Waters, LLC
Source: WDNR Hydro, ESRI Base Maps, MiGDL Lake_polygons_200403
File: PI_Big_2016_v1

EWM Colony Mapping	
EWM Abundance Estimate	Acreage
Very Sparse	5.0
Sparse	2.9
Moderate	1.1
Moderate-Dense	0.9
Dense	0.0
TOTAL	**9.9**

EWM Survey
Big Lake
Cisco Chain of Lakes
2016

Lake: Big Lake - Vilas County, WI & Gogebic County, MI
Map Date & Creator: 1.4.2017, Many Waters, LLC
Source: WDNR Hydro, ESRI Base Maps,
MiGDL Lake_polygons_200403
File: Big_MLSS_2017

EWM Relative Abundance

- Very Sparse
- Sparse
- Moderate
- Moderate-Dense
- Dense

Big Lake - Cisco Chain of Lakes
Mid/Late Season EWM Survey
2017

Table 2: Change in EWM polygon based mapping acreage categorized by estimated abundance 2015-2017 – Big Lake.

Abundance Estimate	2015	2016	2017
Very Sparse	12.00	5.00	0.00
Sparse	4.30	2.90	0.00
Moderate	0.74	1.10	0.00
Moderate-Dense	2.13	0.90	0.00
Dense	0.00	0.00	0.00
TOTAL	**19.17**	**9.90**	**0.00**

Figure 1: Change in EWM polygon based mapping acreage categorized by estimated abundance 2015-2017 – Big Lake.

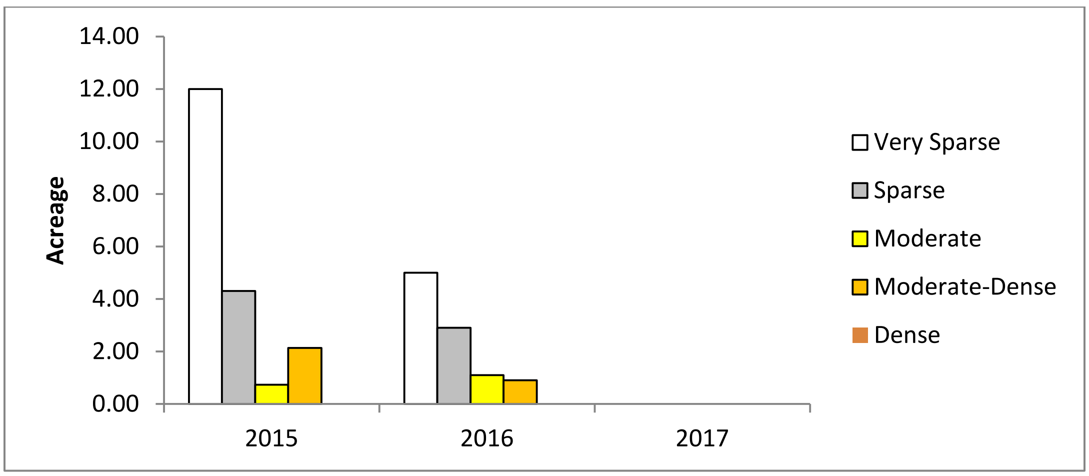
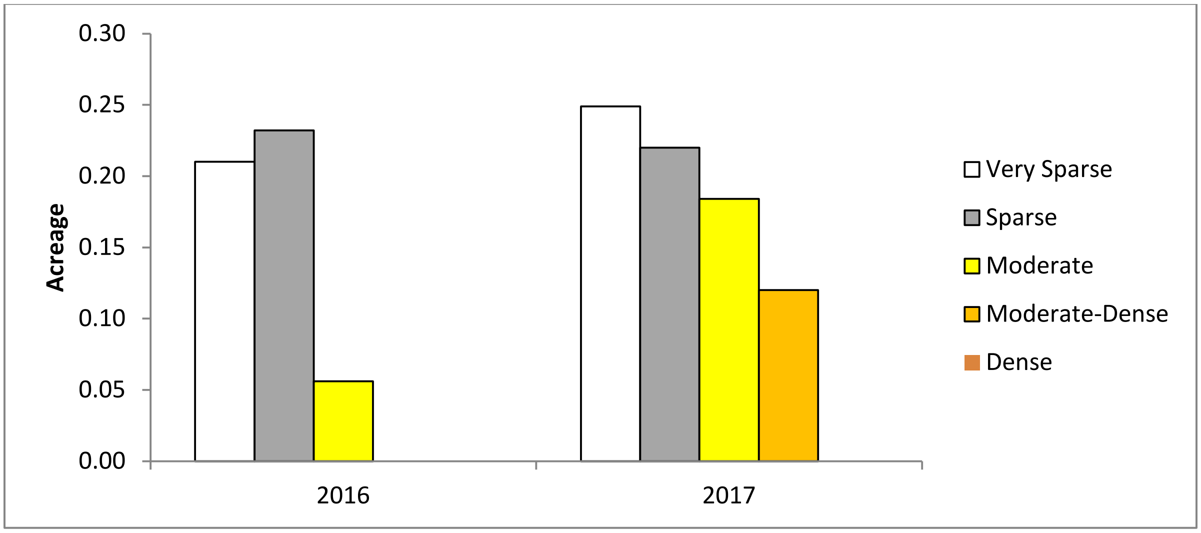


Table 3: Change in EWM point based mapping acreage categorized by estimated abundance 2016-2017 – Big Lake. Note: This is a visual estimate of exact extent, not total footprint. (2015 data not available)

Abundance Estimate	2016	2017
Very Sparse	0.21	0.25
Sparse	0.23	0.22
Moderate	0.06	0.18
Moderate-Dense	0.00	0.12
Dense	0.00	0.00
TOTAL	**0.50**	**0.77**

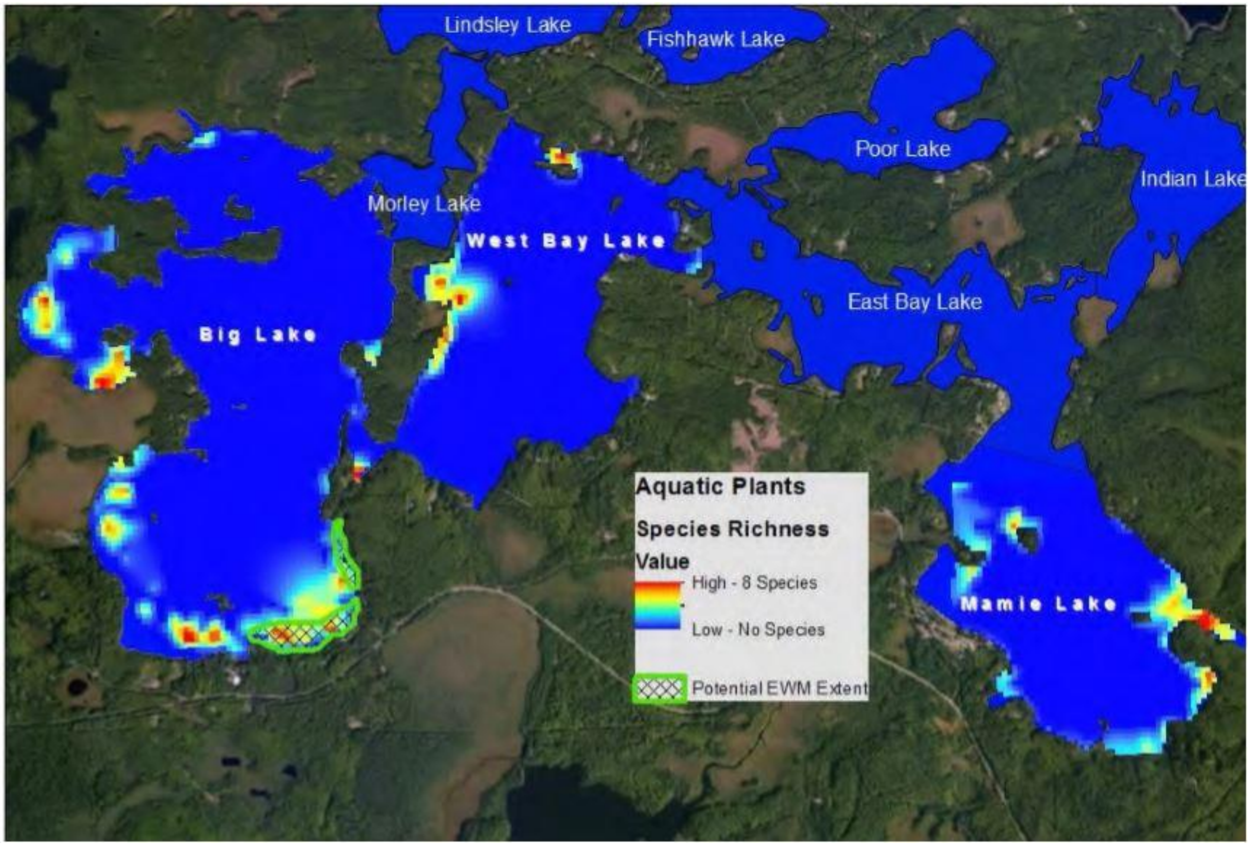
Figure 2: Change in EWM point based mapping acreage categorized by estimated abundance 2016-2017 – Big Lake. Note: This is a visual estimate of exact extent, not total footprint (2015 data not available)

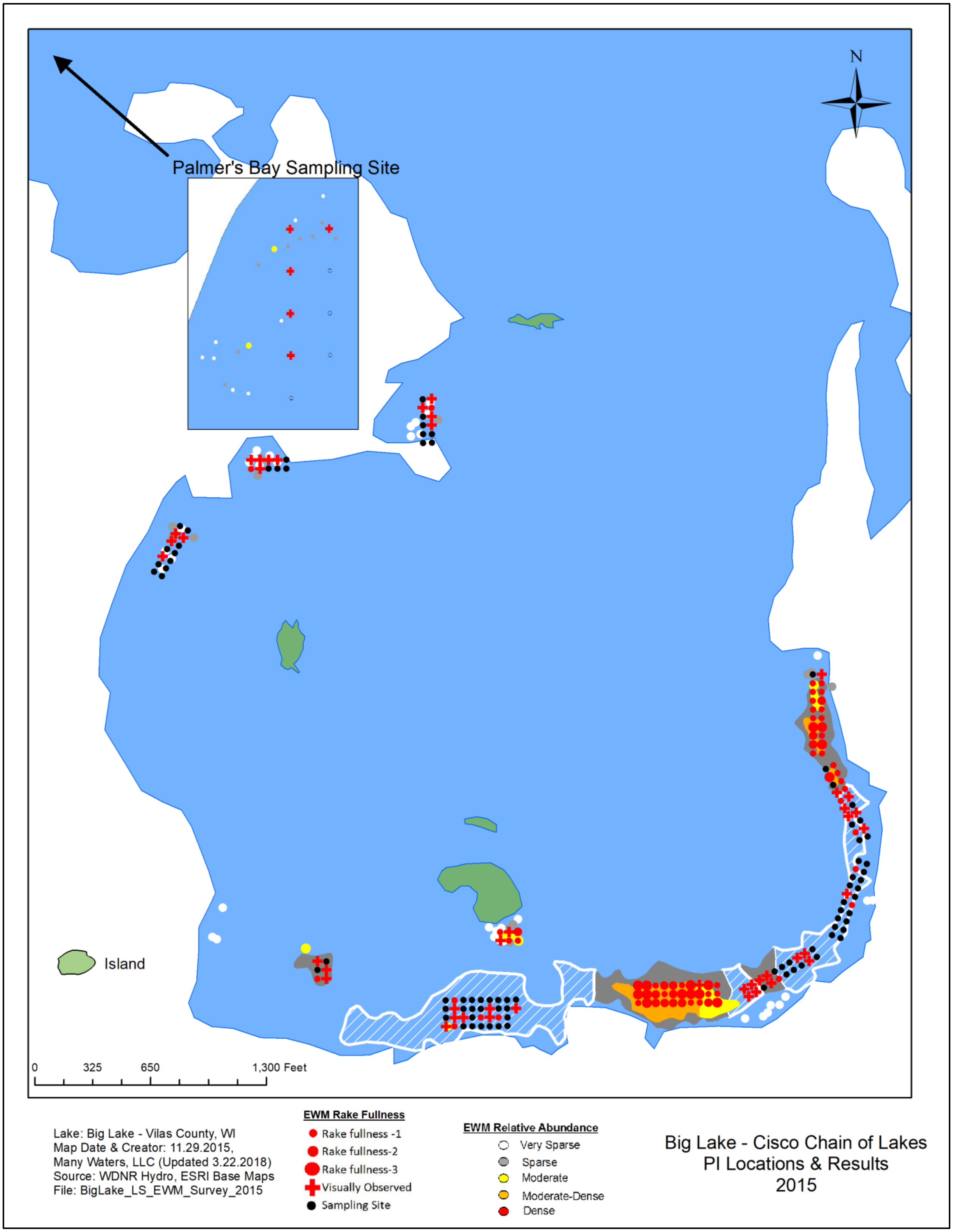


<u>Quantitative- EWM & Native Aquatic Plants</u>

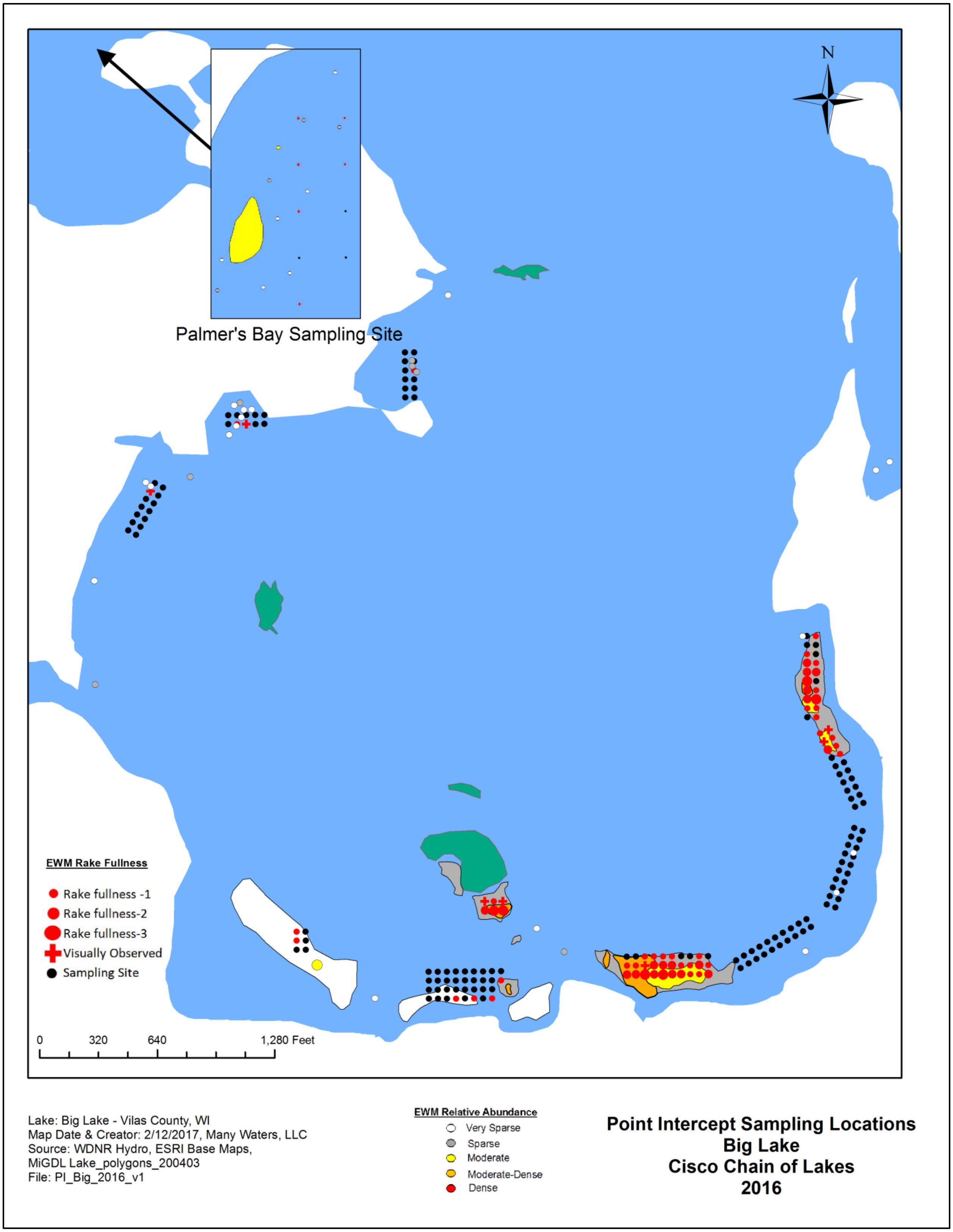
A "sub" point intercept survey conducted from 2015-2017 quantified both the invasive and native plant communities located within selected areas of EWM extent. Initial grid design used a combination of factors including large enough sampling size to detect statistical change and overlap of EWM locations with higher native plant diversity based on the most recent PI survey (Figure 1: Northland College, 2016). Note, sub-PI locations were not initially designed to evaluate a specific proposed management, but rather collect a few years of baseline providing data useful to make management decisions. In 2015, species comprising 10% or greater littoral frequency of occurrence included northern watermilfoil, (41.29%), Eurasian watermilfoil (33.83%), clasping-leaf pondweed (21.89%), fern pondweed (20.40%) and white-water crowfoot (14.43%). In 2016, species comprising 10% or greater percent littoral frequency of occurrence included Eurasian watermilfoil (28.36%), Northern watermilfoil (24.88%), clasping-leaf pondweed (12.94%), and coontail (10.45%). In 2017, species comprising 10% or greater littoral frequency occurrence included clasping-leaf pondweed (22%), common waterweed (18%), coontail (16%), and flat stem pondweed (15%).

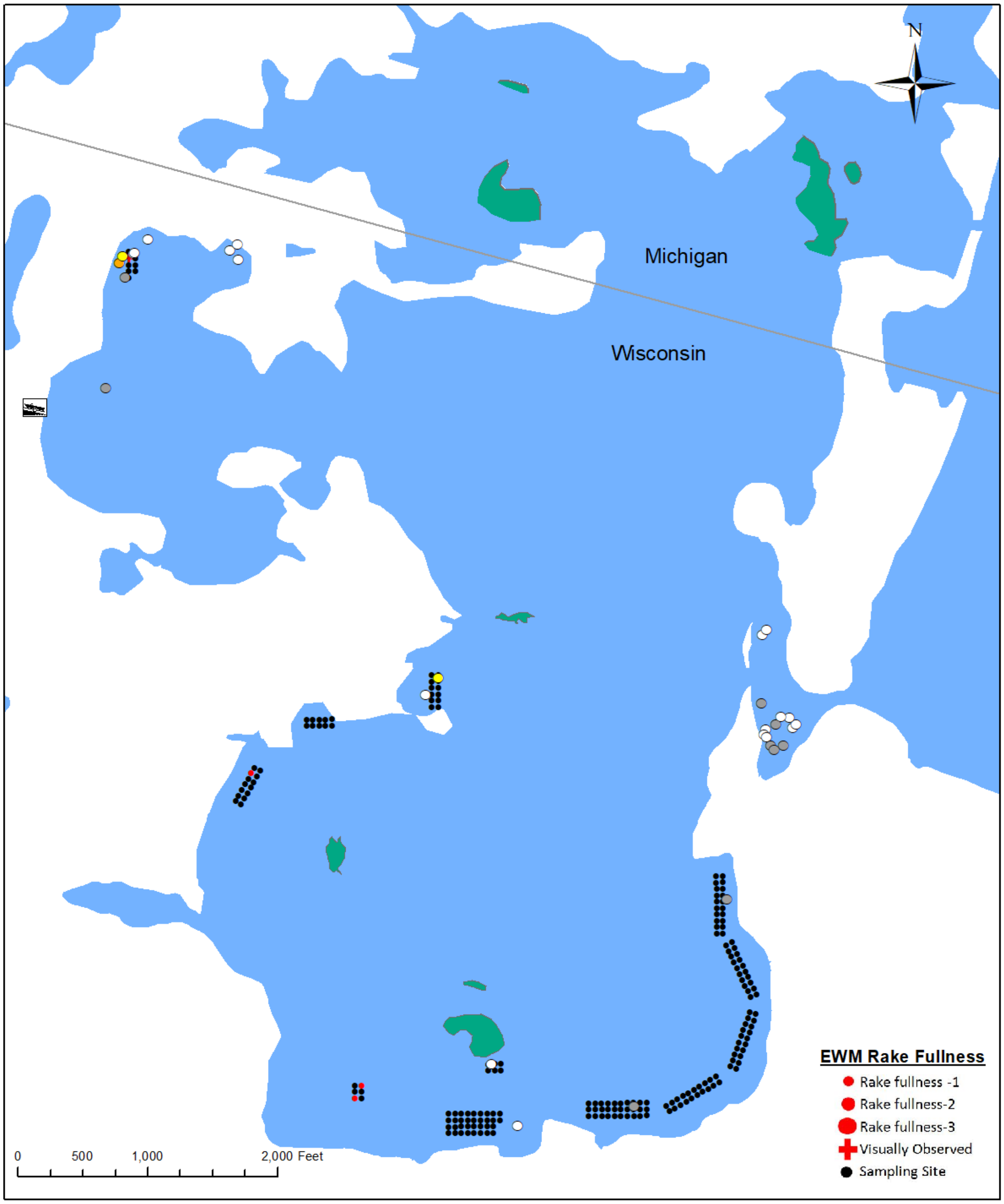
Figure 3: Aquatic plant species richness for Big Lake. Taken from Comprehensive Management Plan for Cisco Chain of Lakes, pg 44 (Northland College, 2016).





N
Palmer's Bay Sampling Site
Island
0
325
650
1,300 Feet
Lake: Big Lake - Vilas County, WI
Map Date & Creator: 11.29.2015,
Many Waters, LLC (Updated 3.22.2018)
Source: WDNR Hydro, ESRI Base Maps
File: BigLake_LS_EWM_Survey_2015
EWM Rake Fullness
Rake fullness -1
Rake fullness-2
Rake fullness-3
Visually Observed
Sampling Site
EWM Relative Abundance
Very Sparse
Sparse
Moderate
Moderate-Dense
Dense
Big Lake - Cisco Chain of Lakes
PI Locations & Results
2015


Palmer's Bay Sampling Site
N
EWM Rake Fullness
Rake fullness -1
Rake fullness-2
Rake fullness-3
Visually Observed
Sampling Site
0
320
640
1,280 Feet
Lake: Big Lake - Vilas County, WI
Map Date & Creator: 2/12/2017, Many Waters, LLC
Source: WDNR Hydro, ESRI Base Maps,
MiGDL Lake_polygons_200403
File: PI_Big_2016_v1
EWM Relative Abundance
Very Sparse
Sparse
Moderate
Moderate-Dense
Dense
Point Intercept Sampling Locations
Big Lake
Cisco Chain of Lakes
2016



Lake: Big Lake - Vilas County, WI & Gogebic County, MI
Map Date & Creator: 2/4/2017, Many Waters, LLC
Source: WDNR Hydro, ESRI Base Maps,
MiGDL Lake_polygons_200403
File: PI_Locations_Big_2017

EWM Relative Abundance

- Very Sparse
- Sparse
- Moderate
- Moderate-Dense
- Dense

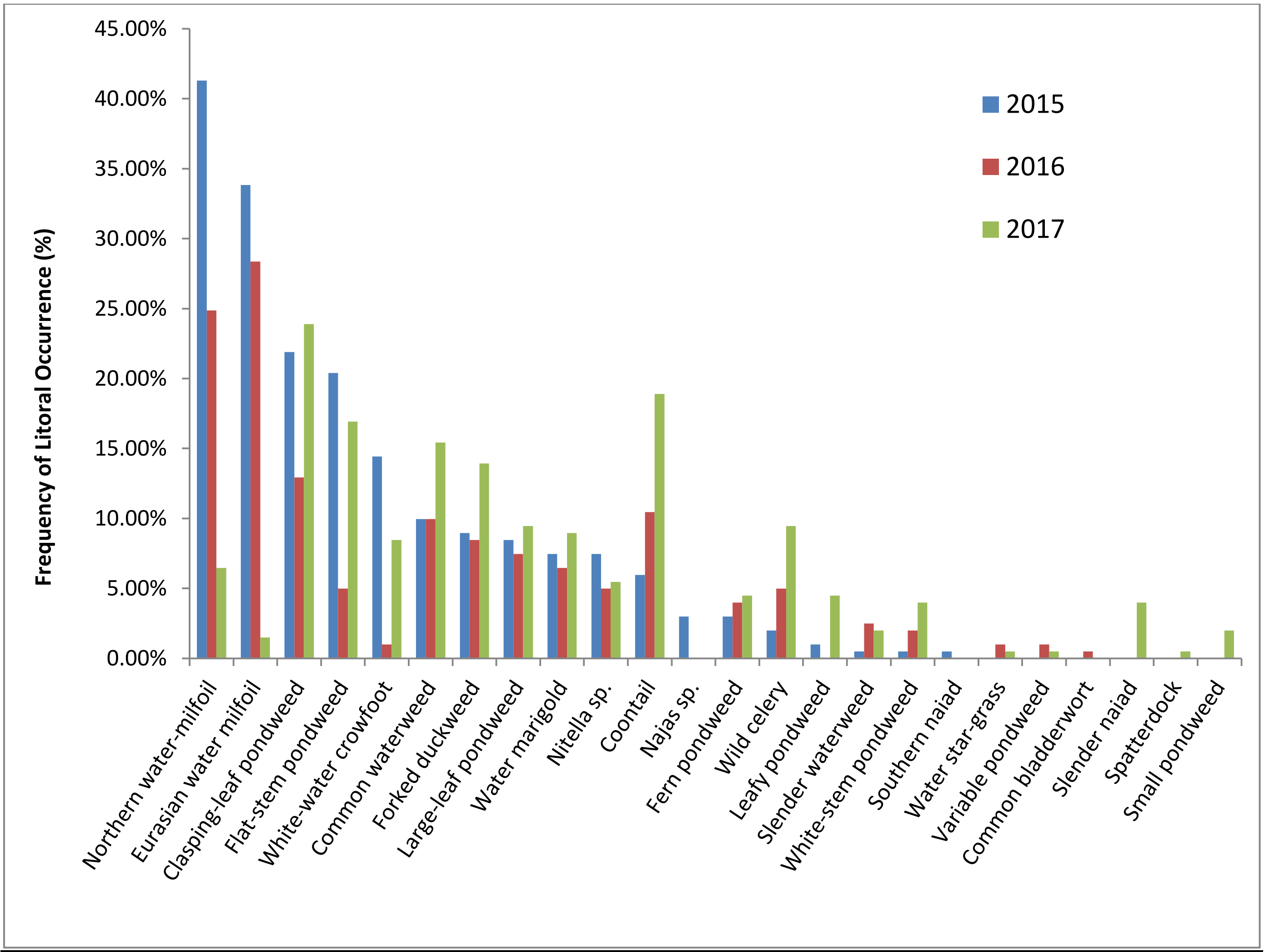
Big Lake - Cisco Chain of Lakes
PI Sampling Locations
Mid/Late Season EWM Survey
2017

Table 4: Summary comparisons of sub point intercept results- Big Lake, 2015 - 2017.

Lake	Big Lake
County	Vilas County
WBIC	2963800
Survey Date	10.8.2015, 9.26.2016 & 8.19.2017
Survey Type	Sub PI - Aquatic Plant Evaluation

SUMMARY STATS:	2015	2016	2017
Total number of sites visited	201	201	201
Total number of sites with vegetation	169	152	152
Total number of sites shallower than maximum depth of plants	201	201	201
Frequency of occurrence at sites shallower than maximum depth of plants	84.08	75.62	75.62
Simpson Diversity Index	0.88	0.89	0.92
Maximum depth of plants (ft)	9.0	10.5	9.0
Number of sites sampled using rake on Rope (R)	0	0	0
Number of sites sampled using rake on Pole (P)	201	201	201
Average number of all species per site (shallower than max depth)	1.91	1.36	1.61
Average number of all species per site (veg. sites only)	2.27	1.80	2.13
Average number of native species per site (shallower than max depth)	1.57	1.08	1.60
Average number of native species per site (veg. sites only)	1.99	1.68	2.13
Species Richness	18	19	21
Species Richness (including visuals)	18	19	21
Mean C	6.38	6.35	6.3
FQI	25.5	26.19	28.17

Figure 4: Frequency of littoral occurrence (%) of detected aquatic plant species from 2015 - 2017 – Big Lake, Vilas County WI.



DISCUSSION AND CONCLUSIONS

Based on the pre and post treatment monitoring within the three treated area in 2017, a statistically valid reduction to Eurasian watermilfoil and Northern water milfoil and a statically valid increase to common waterweed, forked duckweed, flat-stem pondweed, slender naiad and white water crowfoot occurred. These data suggest that herbicide management was successful at annual control of EWM and may have negatively affected the native Northern watermilfoil within the treatment sites. The statistically valid increase in several native species may be a result of these species colonizing areas once dominated by EWM, or a seasonal timing difference in the pre and post treatment surveys. The pre treatment PI survey in 2016 took place in the latter part of September, and some of these native species may have already senesced for the year. Whereas the 2017 the post treatment sub PI survey took place about a month earlier in mid August. Management of EWM may have allowed native species to “rebound” or return to previously EWM colonized sites, however, the seasonal timing of these surveys likely attributed to the increase in native species abundance.

A limitation to the presented data analysis is that it cannot tease out the proportion of change due to management versus change related to other factors including natural annual variability in both the native and invasive plant population. For example, looking at the sub PI results for pre 2016 and post 2017 on all sampling sites not treated; there is a similar downward trend to EWM and Northern watermilfoil. Furthermore, when comparing 2015 to 2016 Sub-PI results, when no management occurred (minus the light hand removal at the far north end of the lake), a similar trend to EWM and Northern watermilfoil occurred. Granted the data from the Sub-PI only offers a short term snap shot of what may be occurring at a population level with both the native and invasive species, but provides some population trends and information on overall aquatic plant community health and stability.

Figure 9: Frequency of littoral occurrence for Sub-PI sites not within treatment area from 2016 to 2017 (n = 146). * Statistically valid change (p<0.05).

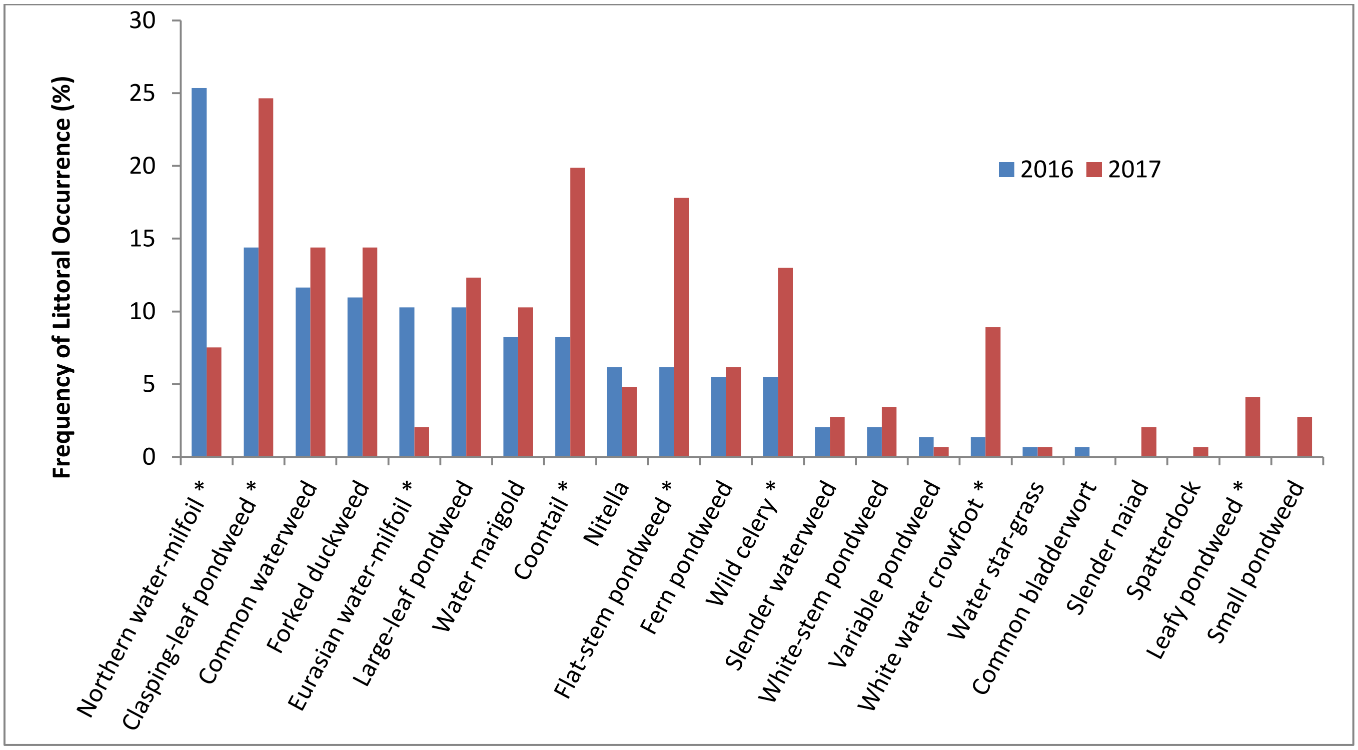
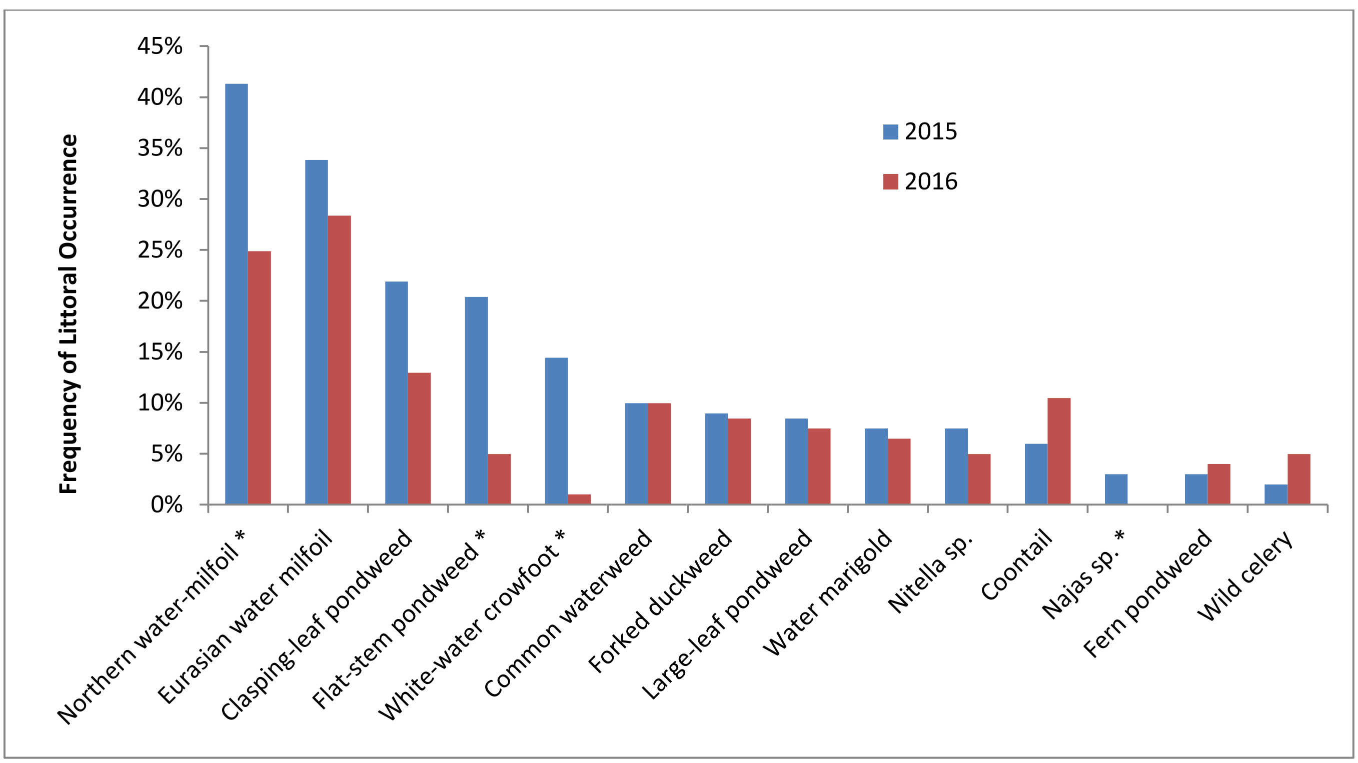


Figure 10: Frequency of littoral occurrence for Sub-PI points from 2015 to 2016 (n = 201). Species with less than 5% not included. *Statistically valid change (p<0.05).



Measured herbicide concentrations within the water column during the time of treatment, did not achieve target levels of 2500 ug/l within the first six hours of treatment, but rather ranged between 157.4 – 453.9 ug/l. Concentrations rose between 1 to 4 hours after treatment then began to decline to the last measured sample at 6 hours after treatment. Having a full 48 hour after treatment picture would be useful to isolated how many hours after treatment herbicide levels remained in the water column at detectable levels, however, much research on this has already been completed by the WDNR and generally after six hours of treatment with granular herbicides concentrations trended downward. One theory is that granular herbicides remain in the sediment, slowly releasing herbicide over a longer period maintaining a low yet consistent level of herbicide concentration. Studies and science regarding the mobility of granular herbicides within the water column and the pore-sediment water interface is not consistent, therefore any conclusions on where or how the granular triclopyr concentrations patterned within the water column, or pore-sediment water is beyond the scope of this project. The intent of providing herbicide concentration information for this particular project is twofold. First, poor results from small-scale treatments many times are attributed to the herbicide not maintaining contact with the plants for an adequate amount of time to provide lethal kill of those plants. Knowing what the concentration of the herbicide is at the time of treatment provides information on possibly why the treatment was not successful. Netherland and Getsinger (1992) looked at herbicide concentration and exposure times of triclopyr in a laboratory study. The observed concentrations seen during the Big Lake treatment are below levels seen in the laboratory for adequate control of EWM. However, the authors caution the application of laboratory results to the field. Secondly, having real time concentration samples for a specific body of water provides information to make informed management decisions in the future and educate lake folks involved in making those decisions on the challenges posed with small-scale herbicide management.

Generally, the Sub-PI data suggests that based on previous years efforts that the overall floristic quality on Big Lake within the sampled locations has remained stable, with no significant net loss of native species. Furthermore, lake-wide levels of EWM have been reduced to non-nuisance levels, not currently affecting recreational use and water body access. Proposed monitoring and management strategies will focus on seasonal lake-wide EWM monitoring, lake-wide population level control of EWM with primary focus on sites that pose the greatest risk for spread (higher traffic areas) and newly colonized sites and continued annual evaluation of the native aquatic plant community using the sub-PI method. Considering the most recent lake-wide PI survey is estimated to be 5-7 years old, repeating this survey to gain recent and comparative data is suggested.

Netherland, M.D. & Getsinger, K.D. 1992. Journal of Aquatic Plant Management. 30: 1-5.